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DRAWINGS ATTACHED

1 326 306

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(19)

(54) FUEL INJECTOR

(71) We, STANADYNE INC., a corporation organised and existing under the laws of the State of Delaware, United States of America of Wilson, State of Connecticut, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates generally to fuel injectors for internal combustion engines and is more particularly concerned with an improvement in the injector described in United States Patent No. 3,224,684 issued December 21, 1965 and entitled "Fuel Injection Nozzle."

In inwardly opening pressure actuated liquid fuel injectors of the type contemplated by this invention, the plunger or valve is lifted from its seat by the pressure of the fuel delivered to the injector from an associated high pressure pump in measured quantities or charges. Each measured charge of pressurized fuel is discharged from the injector into a combustion chamber of an associated engine to operate the engine at the desired speed and torque, and the delivery of fuel to the injector, and its discharge therefrom, is timed to take place at a predetermined time during the compression stroke of the piston in the associated cylinder.

It is important that the injector discharge the fuel in a fine atomized spray. To produce such an atomized spray, the valve of the injector must be free to "chatter," that is, to reciprocate rapidly and frequently between an open and closed position during each injection period. In order to accomplish this, it is essential that the valve be free floating in its guide to avoid seizure or erratic operation of the valve in its guide under all operating conditions and throughout the entire life of the injector.

Accordingly, a primary object of the present invention is to provide an improved injector of the type described having reduced susceptibility to seizure of the valve and related malfunctions under all operating conditions.

The invention provides a liquid fuel injector for injecting into the combustion chamber of an associated engine pulsed charges of liquid fuel received from a high pressure fuel source, comprising a tubular body having a bore provided with a valve seat and a discharge tip at one end thereof, a pressure-operated inwardly opening valve disposed in said bore, biasing means for biasing said valve toward said valve seat, an apertured valve guide closing the end of said bore remote from said valve seat, said valve having a bearing portion positioned in the aperture of said valve guide to mount said valve for high speed reciprocating movement toward and away from the valve seat during each injection period of the valve, and longitudinally spaced peripheral grooves on said bearing portion of said valve, said groove being V-shaped in cross section so that with the aid of liquid fuel present in the valve guide they wedge said valve bearing portion to a central position during such high speed reciprocating movement thereby to overcome lateral forces which may cause binding or seizing of the valve.

The invention will be described further, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a cross-sectional view of a portion of a fuel injector embodying the present invention; and

Figure 2 is an enlarged fragmentary view of the guide portion of the valve of the injector of Figure 1.

Referring to the drawing, in which like numerals refer to like parts throughout the several views, the exemplary injector shown herein and embodying the present invention is generally similar to that illustrated in the aforementioned patent 3,224,684 and includes an elongated generally tubular body 10 having an apertured tip 12 fixed at one end thereof and a central longitudinal bore

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14 extending throughout its length. Located within the central bore 14 is a plunger or valve 16 having a conical tip which cooperates with a conical valve seat 18 formed in the tip 12 to control the discharge of fuel from the injector. A valve guide 20 is shown as being fixedly positioned within the bore 14 of the body 10 at a position remote from the valve seat to slidably mount the valve 16 and position it in coaxial alignment with the valve seat 18.

The injector is provided with a fuel inlet 24 communicating with a bore 14 of the tubular body 10 for delivery of discrete measured charges of high pressure fuel thereto from a source (not shown). A spring 26 disposed in a spring chamber 28 above valve guide 20 biases the valve 16 downwardly against the seat with a pressure which may be adjusted by a threaded retainer sleeve 34 received within the end of the tubular body 10 and locked in adjusted position by a lock nut 36. An adjustable lift stop 40 is also provided for limiting the lift of the valve seat 18.

When each discrete charge of pressurized fuel delivered to the inlet 24 of the injector increases the pressure of the fuel within the bore 14 to a level to overcome the bias of spring 26, the valve 16 is moved upwardly away from the valve seat 18 and the charge of fuel is discharged through the orifices in the valve tip 12.

As mentioned above, it is important for the smooth operation of the fuel injector that the plunger 16 be free at all times during the injection period to reciprocate rapidly so as to produce the proper chatter of the valve and the consequent desired atomized spray of fuel into the firing chamber of the associated engine. This operation is initially made possible through the alignment of the valve 16 with the valve seat 18 and by providing a lapped fit of the surfaces of the bore of the valve guide 20 and the portion of the valve 16 received therein to minimize friction and lateral forces which may cause binding or seizure of the valve 16 in the valve guide 20.

As shown in FIG. 1, a pair of annular recesses are provided between the bearing surfaces of the valve guide 20 and those of the guide portion 16*a* of the valve 16. As shown, the recesses are provided by forming a pair of longitudinally spaced peripheral grooves 50, 52 on the external surface of the valve 16 with the grooves being disposed intermediate the ends of the valve guide 20 so that the mating bearing surface of valve guide 20 overlies the grooves at all times during operation.

Referring particularly to FIG. 2, the grooves 50, 52 are shown as being substantially V-shaped in cross section with an included angle of about 60°. A valve provided with such grooves 50, 52 spaced longitudinally about 100 mils apart with the grooves being about 5—15 mils deep has proven to be satisfactory in carrying out the principles of this invention.

With the grooves disposed so as to be covered at all times during operation by the mating surface of the valve guide 20, they are protected from debris damage and debris accumulation which might otherwise occur as a result of solid particulate contaminants in the fuel.

It has been found that the provision of the double groove construction as described results in valves which will meet the requirements for chattering with a high degree of uniformity from injector to injector and from engine to engine with the result that the rejection rate of injectors provided with such grooves is 1/6 or less than the rejection rate of identical injectors not provided with the grooves.

In a 4-cycle compression ignition engine, the period generally available for the injection of the charge of fuel during each compression stroke is approximately 20° out of every 720° of crank shaft rotation. Where such an engine is operating at, say, 3,000 rpm, the period of time for injection of a charge of fuel is about 0.0111 second. It will be readily apparent that the high, short-term pressures encountered within the bore 14 of the injector during the injection period for such an engine create high differential pressure relative to the pressure in spring chamber 28 which is vented by a bleed passage 42. While the guide portion 16*a* of the valve 16 and the mating surface of the guide 20 are precision sized to minimize leakage into the spring chamber 28 during the injection period, it is apparent that a small amount of leakage will occur. Moreover, the rapidity of the build-up and dissipation of high pressure within the bore 14 during the injection period will also create transient differential pressures within the bore 14 due to hydraulic shock waves and hydraulic inertia. Such transient differential pressures adjacent the guide 20 may establish lateral forces on the valve 16 which bias the valve laterally. Such a condition is self-generating since it results in a greater clearance (and less resistance for leakage flow) on one side of the valve than on the opposite side. This invention minimizes the effects of this condition by providing for the relatively unimpeded flow of lubricant around the periphery of the valve guide portion 16*a* through the use of grooves 50, 52. This serves to centralize the valve and reduce the mechanical friction between the valve 16 and the valve guide 20 by promoting a uniform layer of lubricant around the valve guide portion 16*a*.

Moreover, the rapid reciprocation of the

valve during the injection period to provide the desired chatter, coupled with the tapered shape of the grooves in the direction of reciprocation, establishes an outward component of force on the fuel in the grooves 50, 52 to bias the fuel against the bearing surface of the guide 20 overlying the grooves 50,52. This assists in promoting the establishment and maintenance of a uniform layer of lubricating film around the entire periphery of the valve portion 16*a* thereby offering additional assurance that any tendency of the binding or seizure of the valve is minimized.

From the foregoing it will be apparent that the present invention provides a new and improved inwardly opening pressure actuated injector which substantially aids in promoting the uniformity in the atomization of the fuel discharged therefrom by reducing the possibility for seizure or increased mechanical friction between the valve and its guide.

WHAT WE CLAIM IS:—

1. A liquid fuel injector for injecting into the combustion chamber of an associated engine pulsed charges of liquid fuel received from a high pressure fuel source, comprising a tubular body having a bore provided with a valve seat and a discharge tip at one end thereof, a pressure-operated inwardly opening valve disposed in said bore, biasing means for biasing said valve toward said valve seat, an apertured valve guide closing the end of said bore remote from said valve seat, said valve having a bearing portion positioned in the aperture of said valve guide to mount said valve for high speed reciprocating movement toward and away from the valve seat during each injection period of the valve, and longitudinally spaced peripheral grooves on said bearing portion of said valve, said grooves being V-shaped in cross section so that with the aid of liquid fuel present in the valve guide they wedge said valve bearing portion to a central position during such high speed reciprocating movement thereby to overcome lateral forces which may cause binding or seizing of the valve.

2. An injector as claimed in claim 1, wherein the included angle of each said V-shaped groove is approximately 60°.

3. An injector as claimed in claim 1 or 2, in which each said groove is 5 to 15 mils deep.

4. An injector as claimed in any of claims 1 to 3, wherein one said groove is disposed adjacent each end of the valve guide.

5. A liquid fuel injector substantially as described herein with reference to and as shown in the accompanying drawings.

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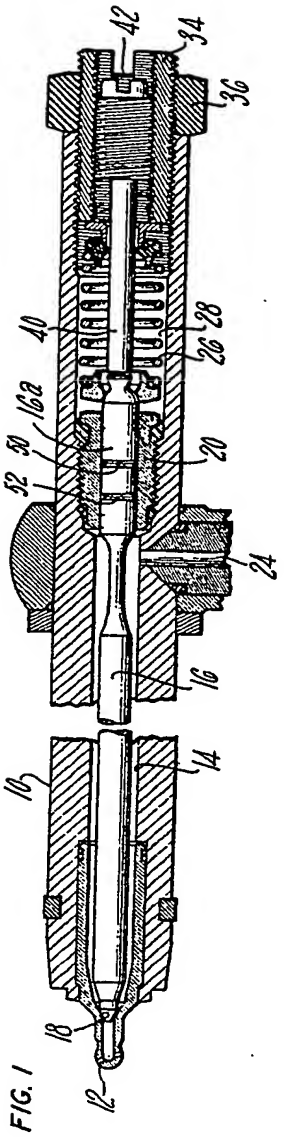

FIG. 1

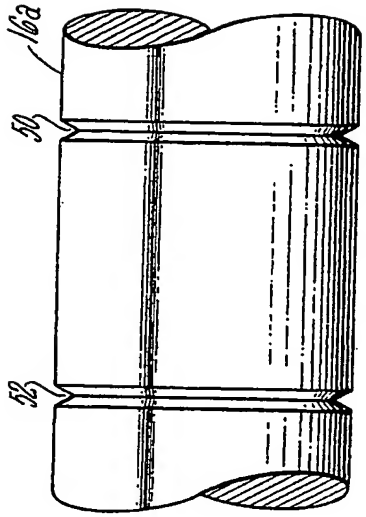

FIG. 2